

INFLUENCE OF LAND HISTORY AND LEGISLATIVE ENACTMENTS
ON THE CHARACTER AND CONDITION
OF THE STATE FORESTS IN MASSACHUSETTS

by

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The relatively long and varied land history of Massachusetts, culminating in large scale farm abandonment and vast areas of cut-over land, together with the low limits of purchase price as specified in legislative enactments for the acquisition of State forest land, has almost wholly determined the character and condition of the State Forests at the present time.

Due to the early settlement of the state and clearing of land for agricultural purposes, much of the original forest growth was cut off early in the history of the Commonwealth. However, about 1850, because of economic changes, the less productive farm land was abandoned, which Fisher (2) says comprised about half of the area now wooded. As time went on, wood-using industries were developed to provide building materials and household furnishings for the ever increasing population, first relying upon what remained of the "old growth", and later depending solely on "second growth". Later exploitation of these stands for charcoal, railroad ties, and for domestic uses caused their further depletion, and inferior hardwood species such as gray birch, red maple, pin cherry, and poplar gradually replaced the better hardwood species.

As the local timber supply approached depletion, many of the smaller wood-using industries were forced out of business, and the state became more and more dependent upon outside sources for its timber supply. Thus in 1870 Massachusetts ranked as the 17th state in the lumber production of the United States, but in 1922

it had fallen as low as 30th place. With the resulting drop in production, the industries turned to the South and West for their raw materials, so that each year saw a rise in importations and a decline in local production. In 1924 Massachusetts imported 677 million board feet of lumber and exported but 22 million, its total production being only 130 million feet (1).

The inadequate supplies of local timber resulted in the promotion of a forestry movement in Massachusetts as early as 1890. At that time the people of the state, sensing the approach of a local timber shortage, called upon their legislators for action. Consequently the State Board of Agriculture was ordered to inquire "into the consideration of the forests of the State, their need and methods of protection", but with little immediate results. About 1904 the people of the state again demanded action, and expressed the desire to own and manage some portion of the timber lands, with the result that a State Forester was appointed in that year.

For the next few years the State Forestry Department was especially interested in gypsy moth prevention work, fire protection, the furnishing of transplant conifers for private planting and for watershed protection on municipal watersheds, and reforestation under the so-called "Reforestation Act". There were no State Forests at this time, but the Commonwealth was purchasing numerous cut-over lots throughout the state on which they planted conifers in an attempt to bring these lots to a forested condition. Under this Reforestation Law, title to the land was passed to the State at a price not to exceed \$5.00 an acre, but the original owner had the privilege of reclaiming this land within a ten-year period upon repayment of the purchase price with interest at 4%

Due to the reorganization of the State Departments in 1919, the Forest Commission was abolished and replaced by a Department of Conservation. According to Chapter 350, General Acts, this department was to be made up of the Divisions of Forestry, Fish and Game, and Animal Industry, each division having a director, but supervised by a Commissioner, the latter to act as director of one division.

The year 1921 witnessed the passage of a law providing for the purchase in the next fifteen years of an additional 100,000 acres of land, not to exceed an average price of \$5.00 an acre. The Forester "was authorized by this act to reclaim such land by planting or otherwise in order to produce timber and protect the water supply of the Commonwealth". In 1921 the total acreage of State Forest land was 33,456, which by 1926 had reached a total of about 108,000 acres. This acreage is distributed throughout the state, varying in size from blocks of a few hundred to as much as 13,000 acres. Most of the land was purchased for less than \$5.00 an acre, but some blocks were acquired by gift, these latter areas as a whole being much better timbered than those purchased, since land with growing timber was not generally available at \$5.00 an acre.

II.

Forest Conditions in the Transition Zone

1. Silvicultural Conditions

Extending as they do from Cape Cod to the Berkshire Hills, the State Forests present a wide range in composition and condition. This study is confined to the State Forests lying within what is known as the Transition Forest Zone, or essentially the central portion of the state (See Fig. 1). The zone is character-

per annum together with any costs of improvement. Many such lots were never reclaimed at the end of this period, so they became permanent State lands and later formed the nucleus of some of the State Forests. The Reforestation Act was aimed primarily toward the protection of stream flow and the reclamation of waste and idle lands, of which there were many acres within the state.

It was not until 1914 that the legislature saw the need of large forest areas under State ownership, and that year saw the formation of a State Forest Commission of three men who were empowered to purchase woodland or land suitable for timber growing within the Commonwealth at a price not to average more than \$5.00 an acre. Such lands were to be under the control and management of the State Forester. At this time the forest land in Massachusetts was estimated at 3,000,000 acres, as compared with a total area for the state of 5,290,240 acres.

The Otter River State Forest of 1800 acres was the first to be purchased under this act. This land for the most part was in a cut-over condition and supported little if any forest growth. The price paid ranged between \$4.00 and \$5.00 an acre. The second area acquired was in Plymouth County where the growth was largely scrub oak, pitch and white pine. The Forest Commissioner's Report of 1916 (7) states that "reforestation will be slow, but the results will be of material value as a State possession, showing the owners of similar land what can be done in redeeming what was once productive land". Five State Forests were acquired under the provisions of Chapter 720, Acts of 1914, varying in size from a few hundred to several thousand acres, and distributed from the Cape section of the state to the Berkshires (6). The Commission reported that "much of this land is as nearly waste and idle land and represents exactly the type of useless land contemplated by the framers of the law".

2. Economic Conditions

The transition zone is the center of the wood-using industry of the state. Among its well known products are boxes, crates, woodenware specialties, furniture, sash, doors, and blinds, toys, and cooperage. According to estimates made from a recent survey of the wood-using industries of Massachusetts, the total amount of wood used in this region in 1926, exclusive of retail lumber, was 179,821,000 board feet, of which approximately 38% or 69,279,000 board feet was produced in Massachusetts. Cordwood is also in moderate demand, a survey showing that there is a possible absorption of 15,000 cords annually within the region and nearby cities. This amount is by no means the total amount used, but only that which it is possible to dispose of directly to wood dealers and brick yards. Tie timber may also come into great demand due to the erection of a creosoting plant at New Haven which allows an outlet for local material on railroads leading to that city.

For transportation facilities, the region is well covered by trunk line railroads and highways which, supplemented by well kept town roads, make all points accessible.

III.

Analysis of Conditions on the State Forests within the Transition Zone with Recommended Treatments

1. Area and General Condition

There are approximately 37,000 acres of State forest land within the transition zone. Figure 1 shows the distribution and sizes of the various forest units within the zone. The larger Blocks (Fig. 1) are State Forest purchases, whereas the smaller areas are either former "reforestation lots" now State owned, or

ized by a great wealth of tree species due to the overlapping of two well defined forest regions, namely the Northern Forest and the Central Forest. Among the principal species found here are beech, maple, birch, oak, ash, hickory, white pine, hemlock, cherry, basswood, elm, and others of lesser importance commercially. Whereas the Berkshire forests are essentially northern hardwoods of beech, birch, and maple, and the eastern part of the state is made up of pitch and white pine and scrub oak, the central portion is well known for its numerous transition and old field types and its abundance of weed species. Thus the composition of the forests becomes variable with the percentage of good and poor species differing in every stand.

Between 1850 and 1870 after the abandonment of the poorer farm lands in Massachusetts, there followed a period marked by the natural seeding in of open fields and pastures. Because of abundant seed trees and its ability to establish itself on old fields, white pine was the principal tree to reclaim the abandoned farms, and thus became generally known as "old field" pine. By the early part of the present century most of these stands had reached maturity and were cut off, which with repeated fires and no attempt in improvement through silvicultural treatment have resulted in stands progressively poorer in composition and stocking.

Other areas in the region, although never cleared for agricultural purposes have undergone a similar deterioration. At first the forests on these areas were culled over repeatedly, always utilizing the better timber. Further demands enabled the lumbermen to clear cut for ties and sawtimber, and with the advent of the railroad and the increase in population, large areas of forest land were burned over until today the remaining growth is composed of an undue amount of inferior species.

Of the cordwood area 10,101 acres would be convertible, and of the sawtimber 11,285 is hardwood, 6,290 acres of which is mixed "better and inferior".

2. Recommended Treatments According to Age Classes

Figure 3 represents schematically the periods in the development of an average stand in this region. By dividing the rotation into three broad age classes, Figure 3 shows the treatments which may be applicable during these periods, each of which has its definite place in the development of a stand. The early years of a stand constitute its formative period wherein silvicultural treatment results in the greatest possible influence upon the composition, form, and quality of the final stand. This period is followed by one of rapid height growth and natural pruning through middle age, in which thinnings and improvement cuttings are the principal treatments, and then by a period of declining growth in which methods of cutting and means of establishing the new crop are the principal considerations.

The remainder of this chapter deals with the present type conditions of the State Forests in central Massachusetts, and points out the treatments which are applicable to each, where such treatments are justified in increasing sawtimber production. Of course State Forests cannot be valued wholly upon their production of sawtimber and other products. Recreation and watershed protection are perhaps quite as important as the production of timber. Certain areas, due to their special value, may be developed purely as recreational centers; whereas other areas, even though of no value for the production of high quality timber, may be of immense value for the conservation of water power or of wild life. One should not lose sight of these facts, even though

smaller State Forest purchases which were intended to be enlarged. These areas have been largely acquired in the past few years so very little forest practice has been undertaken. Since many areas are in need of planting and also because of limited appropriations, reforestation of open lands has thus far been uppermost. Fire protection has also been a necessary requisite for forest management with the result that fire towers, roads, and fire lines have been constructed toward this end.

The State Forests of Massachusetts, as a whole, are still in an unmanaged condition. Being largely cut-over, the stands vary in density and composition with the majority less than thirty years of age. Some areas, although never clear cut, show the results of heavy selection cuttings, a residual stand of poor quality and density. To gain an idea of the distribution of type conditions in this region, see Figure 2. This chart, showing an analysis of several thousand acres of forest owned by the Diamond Match Company within the same region, represents very closely the conditions on State Forests, with the possible exception of the percentage of cordwood stands and open land. On the State Forests general observation indicates that the amount of cordwood areas and open land will be higher with a corresponding reduction in the amount of sawtimber or indeterminate areas. Applying the percentage figures shown in Figure 2 to the 37,000 acres as the total State Forest area in this region, the more important items would appear as follows:

Land area	35,409	acres
Cordwood	12,950	"
Sawtimber	19,055	"
Open land	814	"
Indeterminate	2,590	"

The first point to be considered in planting is the species best adapted to the particular site. The choice of species will vary with soil conditions, the proposed utilization of the crop, and the susceptibility of the various conifers to disease and insect attack. Among the species most favored for planting in this region are white and Norway spruce, red and white pine, and European larch. Secondly, the spacing of the plants will vary also with the proposed utilization, sawtimber trees being more closely spaced than those grown for pulpwood in order to insure early death of side branches with resultant small knots (10). As for the size of stock, both seedlings and transplants may be used, the latter on areas where competition is liable to develop soon after planting.

Up until twenty years of age, stands planted on open mowing land require very little attention, but frequently on planted pasture lands some competition from hardwoods may arise before this time. This is usually due to gray birch, which on account of more rapid growth, overtops the more valuable conifers. Such conditions can be corrected by lopping back the birch or other hardwood wherever it interferes with the plantation.

All plantations starting with 1000 to 1200 or more trees per acre require thinnings during middle age in order to prevent overcrowding with resultant crown friction, slow growth, and red rot. Thinnings usually begin about the 25th year, with a second and third operation in the 35th and 45th years. On all except the lightest soils there is sufficient differentiation into crown classes early in life to show which trees to favor for the final crop. Gradual opening up of the stand allows room for crown expansion, with a consequent increase in vigor, growth, and better

this report is based on the silvicultural conditions and treatments which tend to increase the productiveness of forest land.

Figure 4 is a schematic chart of the various type conditions as they exist on the State Forests. A discussion of forest conditions and treatments is presented in the order shown in the figure. When certain type conditions are omitted in middle or old age, these conditions do not exist under the age class being considered, either having dropped out due to early decline, as with gray birch, or due to the fact that many stands have been only recently established by planting. Stands are considered "young" from the time of their establishment to twelve years of age; middle age stands from twelve to fifty years old; and old stands from fifty years to the end of the rotation. In the case of planted land, the condition of the areas before planting will be discussed in order to show what changes take place, if any.

Planted Open Land

On many of the State Forests of Massachusetts, abandoned farm land is often necessarily included within the forest purchase. Such lands are essentially open, either being abandoned mowings or old pastures too poor for agricultural uses. The mowings recently abandoned are free from any forest growth, but the pasture land may vary from 30 to 90% open, being usually rocky with either brush or inferior hardwoods scattered throughout the area. With these inferior hardwoods furnishing abundant seed from year to year, it is not long before the open land is encroached upon by an abundance of brushy or "weedy" hardwood growth, making the conversion of such areas to those capable of producing sawtimber extremely difficult. By planting such areas to conifers before the brush stage is reached, the conversion is greatly simplified and much more profitable.

competition causes the plants to become spindly and weak until eventually growth falls off and the trees die, allowing the area to revert again to its former brushy condition. By weeding such young plantations in the second or third year, they may develop as well as those grown on open land. The operation known as weeding or cleaning consists in cutting back the overtopping brush that is hampering the growth of the conifers. Either the brush scythe or machete may be used to good advantage in this work, the essential point being to clear an opening around each tree so that it is free to grow. Usually one such operation will suffice except under extreme conditions where a second is necessary after an interval of two or three years.

Planted Cut-over Cordwood Land

Under this type condition, it is assumed at the start that the area is already cleared of standing trees and slash, leaving the discussion of these points to another part of this chapter.

As found on parts of the Wendell and Erving State Forests within this region, cordwood stands consist of such weed species as gray birch, red maple, pin cherry, and poplar. After cutting for cordwood, these areas are dotted with stumps varying in size from 2 to 8 inches. The season immediately after the cutting these stumps (or stools) produce numerous sprouts which in a few years form a thicket of inferior hardwood growth of little value. Such stands, if allowed to mature without treatment, produce only other crops of cordwood.

Before the hardwood sprout growth starts is the proper time to convert such areas by planting. In plantings of this kind it is essential that the planting stock be large and vigorous so as to be able to compete with the hardwood sprouts. Spacings on

size and quality of product in the final crop. In thinnings, the products removed are often saleable, larch finding a market for posts and poles, spruce for pulpwood, and pine for pail stock, woodenware specialties, and box-board lumber.

Planted Brush Land

The usual brush land type on State Forests in this region results from the long abandonment of pasture land which, from lack of grazing gradually becomes covered by numerous species of brushy plants and weed trees. Commonly found are blackberry briars, viburnum, sweet fern, spirea, laurel, alders, and gray birch. The brush itself may not form a complete ground cover, but is more often in thick patches with intervening spaces more sparsely covered. As brushland these areas are essentially idle lands, yielding no revenue, except where the high bush blueberry is abundant enough to be sold for berry rights. From year to year these areas become more and more brushy, progressively impoverished and unproductive, until conversion to a sawtimber crop becomes financially impossible. However, where brush does not completely cover the areas, planting may be successfully carried on.

Brushland planting is similar to that on open land, the spacing being as uniform as possible by "spotting" the trees in between brush thickets. Common practice is to clear away small brushy growth with a grub hoe and plant the tree in this cleared spot. As for the planting stock, it must be vigorous and sufficiently large to meet the competition with the brush and sprouts which arise immediately following the planting.

Within two or three years the brush and sprout growth is invariably found to be overtopping the young plants, shading them in summer and rubbing against them in winter and summer. Prolonged

Cut-over Pine Sawtimber Land

Under old field pine stands in this region, a thicket of hardwoods, usually designated as advance growth, invariably develops. Later when the pine is logged, this hardwood advance growth must necessarily be cut back to facilitate logging. The sprouts sent out from the advance growth hardwood stools, together with seedlings of such species as gray birch, pin cherry, poplar, and paper birch, which come in after cutting, constitute the new stand. Since the hardwood advance growth is small at the time the pine is logged, it gives rise to seedling or sapling sprouts with from one to three stems per stool. Except on the very best soils, the new stand of hardwood sprouts and seedlings seldom forms a complete stocking throughout the area. One reason for this is that hardwood advance growth under pine is oftentimes groupwise, due to irregularities in the pine canopy, variations in soil, and to other minor factors. Hence on cut-over pine land it is desirable to complete the stocking by the introduction of conifers, confining the planting to the more open spaces where the hardwood is either scanty or of poor species or both (2).

Because of the prevalence of the Pales weevil (8), planting must be deferred until after the second growing season following the cutting of the pine. In order to facilitate planting, it is advisable in advance to locate and mark the hardwood groups which are to be left unplanted. Planting the intervening spaces then proceeds without confusion or loss of time. Large four-year transplants should be used in such planting. On account of the improved quality of softwood when grown with hardwood (10), it is advisable to plant valuable sawtimber trees such as white pine, while the spacing of such trees will be largely determined by the

cut-over cordwood land can be wider than on open land, since the sprouts will act as "fillers". The best practice is to space the plants about 8 feet apart, taking care not to plant too close to a live stump.

Practically all of the well known tree species, including white pine, may be planted on cut-over lands in this region. One common method of planting is to alternate rows of two species, first planting the rows of the species most easily seen and then setting out the rows of the second species in between, guiding on the trees already planted on either side.

Within two or three years after planting, weeding is necessary to reduce competition with the hardwood sprouts. The first weeding is usually necessary the second or third year following planting, and a second weeding a few years later. All sprout growth immediately around and above the planted stock is cut back, common practice being to cut low for the first weeding and in the second (and third, if necessary) to cut at such a height as to be just beneath the tops of the conifers yet allowing them freedom to grow. Cutting overtopped and suppressed hardwoods in weeding is a needless expense and only removes trees that might act as excellent fillers, pruning agents, or soil improvers (3) for the more desirable crop trees.

Planted Cut-over Sawtimber Land

On cut-over sawtimber land, conditions of growth are quite unlike those on cut-over cordwood land. The growth following cutting operations may originate in one of two ways which, due to their complexities, need separate discussion.

serve to maintain a high density, so essential to young stands. Weeding has a three-fold purpose, namely, to regulate density, composition, and height growth; and two or three operations may so influence the stand that it is transformed from a crop of almost worthless sprouts to excellent sawlog material.

Planted Cut-over Hardwood Sawtimber Land

Cut-over hardwood sawtimber land in the transition zone is characterized by a growth of large, rank growing sprout clumps, so fast growing and wide spreading in some cases it becomes unfeasible to attempt treatment of any kind until such time as the stand may be cleared for cordwood and then planted immediately before any sprouting starts. In some specific instances where the sprouting capacity of the older stools is weak from old age, planting of conifers becomes practical. In such cases, if the area is completely planted, the operation becomes one similar to planting cut-over cordwood land; or if enough small stools are present to produce seedling sprouts, groupwise plantings may be made.

Within two years after planting cut-over hardwood areas, the sprout growth will completely dominate the planted conifers. Being of little value these sprouts must be weeded out in order to save the planted stock. Thus no care is necessary in saving any of the sprouts, the essential aim being to open up a space around each planted conifer. Since the sprouts from medium and large stools grow rapidly, the weeding operations must be repeated as often as every two years until the conifers are sufficiently large to keep abreast of them. Although expensive, weedings of planted cut-over hardwood sawtimber areas must be carried out if conversion to a worth-while crop is desired.

amount of hardwood filler within the area. Due to the fewer trees required per acre, the cost of stock and labor will be materially reduced.

The young stand in this case is composed of separate groups of planted softwood and natural hardwood sprouts. In the softwood groups, scattered hardwoods are invariably found overtopping the planted stock and beginning to shade them out. Since the object here is to bring the conifers through to maturity as a group, the necessary operation is one similar to that of weeding a plantation of conifers on cut-over cordwood land.

The hardwood groups offer more complexities. In addition to hardwoods of good species and form, there are always both seedlings and sprouts of inferior species as well as large, multiple sprouts of good species which, on account of their form, must be considered weeds. The weed species and coarse sprouts are usually dominant, whereas the better hardwoods of desirable form make up the intermediate and suppressed crown classes. If allowed to go untreated, such a condition would mean the elimination of the better species in favor of the more rapidly growing weed trees with a consequent loss of sawtimber material in the final crop. Correction of this condition is accomplished by timely weedings, which should begin as early as the second or third year, with one or two more following a few years apart. Single stems of red oak, white ash, and paper birch should be favored as the better trees, while a second choice includes basswood, hard maple, and black cherry. Undesirable or rank growing sprouts should be cut back in order to develop a stand of the better species at an even height; but trees normally under suppression should be left uncut, since they will be eliminated later in life by the faster growing trees, and at the present time they

other hand, where there is but little differentiation into crown classes, the removal of trees from the lowest crown classes is the approved method (German method, "thinning from below"). In either method it is best to make the operations light, especially at the start, with the last operation removing all trees other than those decided on as crop trees.

As old stands, white pine on old fields is usually slow growing and subject to red rot, due to over stocking, except where previously thinned. On the better sites an advance growth of hardwood is oftentimes present underneath. Pure pine stands over 60 years of age should be prepared for final cutting and for the establishment of the new stand.

There are several methods of cutting used in the white pine type of this region. They include (1) clearcutting and planting; (2) clearcutting in a seed year; (3) the shelterwood method; and (4) the group selection method. In the first mentioned, the stand is clear cut and the slash burned. This method is more adaptable to small operations, allowing the stand to be removed in one cut and thereby reducing the operating cost to a minimum, and insuring a new crop by planting.

In the second method the stand is cleared as before, but following an abundant seed year. The slash may be piled and burned as the operation progresses or allowed to dry for burning later. All hardwood advance growth is cut back to facilitate logging and to reduce hardwood competition to a minimum, as well as to secure an even start of hardwood sprout growth in the new crop (2). As before, the operating cost is low, but reproduction is not always certain.

In the shelterwood method of reproduction several cuttings are made (usually two or three), the first taking place as much as

Old Field White Pine

Throughout the transition zone whenever conditions for seed production and germination are favorable, abandoned farm lands are still being seeded to white pine. Occasionally some gray birch and other hardwoods may seed in at the same time, in which event it should be weeded out before it can develop enough to shade the slower growing pine beneath it. One weeding operation is generally all that is necessary, whereas frequently the pine has freedom of growth from the start so no weedings are required.

In middle age pine stands, liberation cuttings or releases such as just described may be necessary, unless the stands have been previously weeded. More often where the gray birch is scattered, the pine has closed together, forming a dense thicket of slender trees, which suffer from both root and crown competition with a slowing up of growth. The better trees in stands twenty to twenty-five years old have long internodes, small lateral branches, and long dead length of bole supporting dead limbs - ideal conditions during early life, but quite unsatisfactory for increment growth at this period. Oftentimes 1500 to 2000 trees per acre are present, when about 300 crop trees are desirable at the end of 60 years.

Such conditions in white pine stands are alleviated by thinnings, beginning about the 25th year when the dead length is about half the total height of the tree, with later thinnings about the 35th and 45th years. The method of thinning will depend largely on local conditions. Where crown classes are well defined, the process involves the removal of relatively few dominant and co-dominant trees which are interfering with the best dominant trees to be left (French plan, "thinning from above"). On the

Hardwood Originating on Cut-over Pine Sawtimber Land

As pointed out previously, sprouts from hardwood advance growth under old field white pine may form the basis of a new crop following pine logging. The stools of the advance growth (commonly cut back at the time of logging), being of small size and of commercial species, produce satisfactory seedling sprouts. Also, following the cutting, other hardwoods such as paper birch, gray birch, and cherry seed in. Thus, the composition is a mixture of sprout and seedling hardwood which, due to their different rates of growth, need treatments which will regulate their density, height growth, and composition to suit the will of the practising forester. These factors are regulated by weeding, an operation which in this particular case is no different from that already discussed under planted out-over pine sawtimber land.

Untreated middle age hardwood stands of this origin are composed of numerous species of both seedling and sprout origin. Among the desirable species present are red oak, white ash, paper birch, hard maple, black cherry, and basswood, whereas the undesirables are red maple, pin cherry, gray birch, and poplar, as well as rank growing sprouts of desirable species, which are essentially weeds. Natural stands composed of these various species are oftentimes dense thickets of stems of all sizes and heights struggling toward the light. Some are poorly formed, broken, or short-boled, so are of little commercial value, but at the same time they occupy valuable space in the stand. To eliminate these worthless individuals, improvement cuttings and thinnings are carried out, the former for the purpose of removing weed trees such as in weeding, the latter to increase the growth in the trees remaining. In most hardwood stands of this region, a method of thinning such as the French will be found satisfactory.

ten years previous to the final cutting. This first, or reproduction, cutting may remove as much as 40 to 50% of the total volume to allow the canopy to be sufficiently opened up to start pine reproduction. All dead, overtopped, intermediate, and some of the upper crown classes should be felled, leaving well formed dominant and co-dominant trees to produce good seed. In all cases misshapen "scrub" trees should be removed in the first cut. Logging is preferable on bare ground so that the litter and humus are mixed up into the mineral soil to make a suitable seed bed. The slash is burned in small piles as the logging progresses. Hardwood advance growth is cut back as in previous methods. Following a seed year and favorable germination, the pine reproduction is allowed to develop several years before the final cutting is made (8). The final cut removes all of the remaining mature pine with as little damage to the pine reproduction as possible, and all hardwood advance growth is cut back as before. Slash seriously hindering the development of the future crop is burned; and if this is done on heavy snow, damage is reduced to a minimum.

The group selection method is used in pine stands of uneven age on the lighter soils of this region. These stands are characterized by two or three distinct age groupings with little hardwood growth present aside from scattered gray birch and other weeds. Cuttings first take place in the mature groups, allowing the other groups to develop and to produce seed to fill in the openings made. Thus by the time that the next age group has reached maturity, the openings are seeded in and the cycle may go on as before.

Hardwood on Cut-over Sawtimber Land

Hardwood on cut-over sawtimber land may originate in one of two ways. Since each case requires somewhat different treatment, they will be discussed separately.

Hardwood Originating on Cut-over Hardwood Sawtimber Land

Young stands of this origin are composed chiefly of coarse, multiple sprouts from medium and large stools, together with some seedling sprouts where hardwood advance growth was formerly present. Advance growth of better hardwoods, however, is very often lacking. Where the growth is uniformly multiple sprout clumps, no treatment to obtain better quality is practical. The best procedure is to allow the young stands to develop untreated, to be cut later as a cordwood crop, and then converted by planting to some species of greater value. Frequently on the better sites, a hardwood advance growth may be present previous to cutting off the old stand, making available a good proportion of better seedling sprouts in the ensuing stand. Where these are abundant enough to form a complete canopy, they should be favored over any coarse sprout growth. One or two weedings are justified in stands of this nature.

Middle age stands of this origin are commonly composed of both weed trees and desirable trees, either as sprouts or single stems. Sprout clumps generally persist, arising from a common stool and spreading out as the crowns demand more space. If better hardwoods of seedling origin are present, they are subordinate to these inferior sprouts. Stands of this nature which have a good proportion of the better elements present may be helped out by improvement cuttings. An operation of this kind removes inferior trees, both sprouts and damaged or poorly formed stems which are crowding and overtopping the better elements of the stand. Since the material removed is of medium size, improvement cuttings oftentimes yield a revenue from the sale of posts or cordwood.

Quite often hardwood stands at this stage are too inferior in composition to warrant any treatment whatsoever. In this case

This method (thinning from above) involves the removal of some dominant and co-dominant trees that interfere with the best formed and properly spaced dominants selected as crop trees. The French method of thinning as applied to hardwoods allows for greater crown expansion of trees which are left, and also insures the highest intermediate return, since the material removed is larger than that removed under other methods.

In old age, hardwood stands which originated on cut-over pine sawtimber land unless previously treated are composed of many species - both good and bad - whose yield is mostly cordwood. The treatment of such stands resolves itself then into the proper methods of final cutting and of reproducing.

The principal reproduction methods in use are clear cutting and planting, and the coppice method. Of the two mentioned, clear cutting and planting is the most certain way of starting a new crop of suitable species of softwood, either developing the new stand as purely coniferous, or as mixed softwood and hardwood. This method is applicable to mature or overmature stands. Following the logging operation the slash is piled and burned so that planting can proceed almost immediately.

The so-called coppice method is applicable to somewhat younger stands of hardwood where large size timber is not desired. As in the previous case, the area is clear cut; and the sprouts from the resultant stools together with some seedlings form the basis of the new crop. This method, when practised from one rotation to another produces inferior quality timber, except on the richer soils where early weeding may result in an appreciable betterment.

the encroachment of the hardwoods upon the slower growing pine. Thus, large marginal hardwood trees should be removed, if it is still desirable to keep the groups separate. If the groups are large and free from hardwoods, they will often be found in need of thinning. Such thinnings should only be carried out in densely stocked stands, allowing the better trees, properly spaced, to develop as the ultimate crop trees.

In the hardwood groups during this period, conditions are no different from those in stands of hardwood originating on cut-over old field pine lands. Thinnings may be carried out here as previously discussed under that section.

In old age, pine-hardwood mixtures, unless previously treated, usually contain only a small percentage of pine. The pine groups have been gradually reduced until perhaps only a few individual pines remain. Where this is true, however, they are of excellent quality and free from limbs. Under such stands it is common to find both hardwood and pine advance growth; and to take advantage of this as a means of reproducing a new crop, clear cutting offers the one practical method of harvesting the mature crop. This method allows all of the timber to be removed in one operation, care being necessary only to protect the pine advance growth. Hardwood advance growth as far as possible should be cut back to enable sprout growth to start at the same time. After cutting, the growth on the area will be a mixture of pine advance growth and seedling hardwood sprouts. Planting may be necessary to supplement the natural pine reproduction, so that the pine groups will be large enough to compete safely with the hardwood sprouts.

Mixed stands of pine and hardwood are conducive to higher quality in the pine, and to the maintenance of desirable soil

they are allowed to develop to cordwood or tie-timber size, and then clear cut. New stands may then be developed immediately following the final cutting by using proper methods of forest management.

Pine-Hardwood on Cut-over Sawtimber Land

Mature pine cut in a seed year often gives rise to a fair proportion of pine reproduction in the new stand. This normally occurs more or less in groups among hardwood sprouts and seedlings (2). In the pine groups scattered hardwoods are also present, and the competition, both from within the group and from the hardwoods surrounding the groups, begins early. This competition varies with the site, being more severe on the heavier soils and less severe on the light and sandy soils, so that on the poorer sites a smaller group will be sufficient to ultimately "pull through" several mature pines (2). Uncontrolled competition from hardwoods often results in the total loss of pine reproduction.

Obviously then the first treatment in a pine-hardwood mixture is to segregate and develop groups of each element through weedings. This is partially accomplished by taking advantage of the naturally formed pine groups scattered over the area. The first essential is to keep the groups intact and well defined, after which the groups may be considered as almost separate units and weeded accordingly. In the pine groups, the operation becomes a liberation cutting or releasing, and in the hardwood groups the operation calls for the removal of weed species, poorly formed trees, and rank growing sprouts. Two operations are usually sufficient to separate the groups and to regulate the composition and distribution of stems.

By middle age when the groups are small, untreated pine-hardwood mixtures are in danger of reverting to hardwoods, due to

Hardwood Swamp Areas

As seen in Fig. 4, hardwood swamp areas are found to be represented in all age classes throughout the State Forests. Such areas are characterized by a predominance of red maple which, due to the moist condition of the soil and to prolific sprouting, cannot be economically replaced by species of better commercial value. These swampy hardwood areas may occur at all elevations, being as a rule, small moist pockets within other forest types. Mixed with the red maple there is usually a small proportion of gray birch, yellow birch, elm, and red oak. Hardwood swamp areas of this kind constitute a permanent type in the forest and therefore offer a crop of pole wood or cordwood on a short rotation. Thirty to forty years is sufficient to grow timber of this size.

Inferior Hardwood on Open Land and Burns

Under this classification are stands which originate by the seeding in of old fields and pastures to gray birch, or by the seeding in of burned-over areas to poplar, pin cherry, and other inferior hardwoods. Few of the better hardwoods are present, so unless such a stand is cut back early in life and the area planted, it must then develop as cordwood to be cut when of merchantable size. Conversion to a sawtimber stand is then accomplished by planting.

The best method for cutting cordwood is to let contracts for the operation, starting in early fall and continuing through the winter. The wood is piled on the lot and yarded to nearby roads when most convenient. In the spring just before planting, the brush must be disposed of by burning. This is usually handled in one of two ways. One method is to pay the choppers more per

conditions, not to mention numerous other advantages of mixtures as opposed to pure stands (2).

Pine and Gray Birch on Old Fields

Pine and gray birch are often found seeding in together on abandoned fields and pastures, and within a few years the gray birch overtops the slower growing pine. Such a condition, if allowed to continue sufficiently long, results in eliminating the pine by shading and abrasion. Gray birch, an out and out weed species, would then form the new crop. Pine and gray birch mixtures are prevalent on the Otter River, Wendell, and Erving State Forests.

Where such a stand has a uniform distribution of pine beneath the birch, weeding out the birch becomes profitable. Here two factors may influence the proper time of the operation, namely, the "critical age" of releasing for the best recovery of the pine, and the most favorable age for a financial return from the sale of birch cordwood (9). As the demand for gray birch cordwood is rather limited (See Table 1), it is usually best to weed early before the pines have become weakened. All gray birch should be lopped back, thus giving the pines light and freedom for growth.

The birch tops in this case should be laid close to the ground where they are in close contact with the mineral soil, and in a few years they will be completely decomposed. The birch may be cut at any season, but under extreme cases of suppression a spring operation is preferable in order to give the liberated pines a chance to "toughen up" under summer conditions, rather than to lose many trees by snow breakage the following winter, if cutting is done in the fall.

Stands of miscellaneous composition, scattered throughout the State Forests, offer a limited supply of material for some specific nearby industry, and thus may be nicely operated under the selection system of cutting.

Summary of Type Conditions and Treatments

The type conditions as represented on the State Forests show a wide variation as to composition and age, and those discussed in the previous chapter are more or less clear cut cases. However, stands which show the characteristics of two or more type conditions may be treated in a modified way most beneficial to those species represented. In any event, the fundamental factors governing forest management are essentially alike.

In the discussion of the various forms of forest management, certain specific treatments have been recommended. A summation of the essential points for each may prove beneficial.

Planting

Forest planting in this region is an operation generally carried out with a crew of two men, one of whom makes the hole and the other follows and plants the tree. The common tool used in digging the holes is the mattock or grub hoe, although the Harvard Forest has favored a special planting tool which makes a straight slit hole of uniform size and shape.

Previous to planting, however, some care should be given to the choice of planting stock to insure vigorous trees. The selection of desirable parent trees as a source of seed and the sorting over of trees in the nurseries is one way of building up our future forest crops.

Care should also be exercised in planting to see that the trees are firmly planted with the rootlets spread and not too

cord, having them pile and burn the slash as cutting proceeds. The second method is to leave the slash where it falls. When the time is suitable for burning, fires are started and the brush is then collected and burned. Either method may be adapted to certain localities, and experience shows that the costs are practically the same.

Cordwood cutting may vary in cost from \$2.50 to \$3.50 a cord, and the usual yield from inferior hardwood stands of this region is from 10 to 15 cords per acre. Brush disposal costs average \$10.00 an acre, except where the stands are cut before the leaves fall, and the brush is piled by the choppers to be burned later.

Miscellaneous Stands

Aside from the stands already mentioned in middle age, there is also a small percentage of others to be found on State Forests of this region. These include softwood swamp or bog; pine, hemlock and hardwood; pitch pine; and white pine and hemlock. Generally these stands are uneven-aged, and because of this fact, very little treatment is applicable. However, where hemlock is uniformly prevalent as an understory, and where the overstory may be suitably marketed, removal of the latter results in a great increase in the volume of the remaining hemlock (5).

As certain groups or individuals in these uneven-aged stands reach a merchantable size, they may be cut by the selection method, allowing the smaller growth to develop until that becomes sufficiently large. Most of the species represented will reproduce themselves by seed, and eventually the openings made by such a cutting will be reproduced to seedling growth. No cutting should be too severe, and the openings should be left clear of thickly piled slash.

individual area offers new possibilities. Generally two or three operations are necessary, starting as early as the third or fourth year after the formation of the crop, and with two to four years between operations. The best seasons for these operations are in those parts of the year when the hardwood is bare of foliage. This makes it easier for the workmen to move about the area and to analyze conditions of composition and distribution, especially in the first operation. The tools used in this work are the brush scythe, machete, brush hook, and light axe. Machetes may be obtained in various sizes and shapes according to the individual tastes of the workmen; a 12 to 14 inch blade is considered better than those of longer length. Light axes are used for the larger growth of sapling size. In the removal of the undesirable trees, the cutting need not necessarily be low or the stems completely severed; in fact cutting within easy reach of the hand and partial severance retards further sprouting to some extent.

Labor costs vary with the age of the stand, but an average figure is about \$4.25 per acre for each operation, equal to an acre per man per day.

No attempt should be made to adjust all factors in one operation. Several light cuttings will be found to be less expensive with a better chance of molding the stand into one of excellent sawtimber species.

Thinnings

The most important operation during middle age is thinning. Generally all stands, whether natural or artificial in origin, require one or more such operations. Thinnings relieve the better trees of a stand from undue competition for light, soil moisture, and food. The operations may begin as early as the 15th

deeply covered with earth. Spacing and species will vary with the intended utilization of the final crop and the presence of fillers, pruning agents, or trainers at the time of planting. Generally in field planting 1000 to 1200 trees are used to the acre. Both fall and spring planting are possible, but the greater success is obtained from early spring operations. Fall plantings produce better growth during the first season in the field, but losses often result from frost heaving unless the planting is very carefully done. Fall operations should be reserved for those places too inaccessible on account of bad spring roads.

In this region each two-man crew usually handles from 800 to 1200 trees a day, depending on the ground cover. In terms of acreage cost, this becomes equivalent to \$6.00 to \$12.00 an acre.

Weedings

During the age of young stands, weedings are of prime importance, in fact no other forest operation in later life can more favorably affect the final crop. The chief objects of these operations are to regulate the composition, density, and height growth of young stands, especially hardwood. This is accomplished by removing overtopping inferior trees or cutting back dominant poorly formed or rank growing individuals of good quality. The better hardwood species favored in this State are red oak, white ash, paper birch, hard maple, black cherry, and basswood. For the production of sawtimber, these trees should be either of seedling or seedling sprout origin.

In operations other than simply releasing natural pine or plantations, a forester's supervision is necessary, since weeding involves a careful analysis of growth conditions, and each

Generally all middle age stands in central Massachusetts, unless previously weeded, are in need of at least one improvement cutting. The purpose of such a cutting is the same as that of weeding, but in this case it becomes more difficult to correct the factors of proper density, height growth, and composition, showing that it is more feasible to do this earlier in life.

As in weeding, the operation should always be under the supervision of a forester, and the trees to be cut should be marked previous to the cutting. In pine and inferior hardwood mixtures, providing the pine is abundant enough, such a cutting removes the overtopping inferior hardwood to allow the pine freedom to grow. In hardwood stands it calls for the removal of dominant weed trees or large spreading sprout clumps where they seriously interfere with better seedling or sprout hardwoods. As in weeding, the species favored as final crop trees are seedling or seedling sprout red oaks, white ash, white birch, hard maple, and basswood. Frequently improvement cuttings will be deferred until the product removed is sufficiently large to be utilized as posts, poles, or cordwood.

IV

Costs of Silvicultural Operations on the State Forests of the Transition Zone

The labor cost for the several major forest operations will vary according to the condition of each area treated, but an average figure computed from several sources shows a marked similarity. The cost figures quoted here are an average from those furnished by the State Division of Forestry, E. Murdock Company, the New England Box Company, and the Harvard Forest,

year, or when the dead length of the stem is equal to half the total height of the tree. Later operations should be made so as to keep the ratio of crown equal to one third of the total height. It is best that early thinnings be light in nature, increasing in severity with age, so as to safeguard the stand from windthrow, so common to stands with one severe operation in later life.

A common method of operating is to mark all trees to be removed according to the system desired to be followed, the choppers then felling the trees in a small area toward a common center and piling the slash and tops to be burned as the cutting progresses. Early thinnings may not always bring a financial return, so that frequently the operation will be deferred until it is able to do so. The products of thinnings in middle age may be disposed of as cordwood, posts, poles, pail stock, and in old age as box board timber and lumber.

There are several advantages derived from thinning. The most important is that it offers an immediate return from salable products. At the same time the initial investment is materially reduced in the ratio of the amount of timber removed, but it allows the bulk of the stand to make increased growth before the final cut is made.

Improvement Cuttings

The definition of such a cutting is one similar to a weeding except that it is applied to stands of the sapling size rather than those of younger age. In some cases it may be similar to a thinning and may be carried out during the same operation, in which case it may be known as an "improvement thinning".

composition, growth, and density on treated areas with those untreated prove beyond doubt that practically all of our natural stands need attention at some time during their life cycle. Fisher (4) shows by quarter-acre sample plots an example of mixed pine and hardwood growth where the board foot measure is increased from 3229 feet in the untreated plot to 8080 feet in the treated one on a corresponding site. To be sure in this case the increase is due primarily to the increase in the number of pines salvaged in early life by weeding, but such an operation would apply to pure hardwood stands only in a less marked degree. With lumber at \$27 per M, such an increase due to weeding is equivalent to about \$500 an acre.

Other values of management, although not so well recorded on a dollar and cents basis, are seen in the fact that stands may be grown on shorter rotations by eliminating undue competition. Thinnings may also furnish early returns, thereby reducing initial investment charges.

The disposal of intermediate cuttings is a requisite for extensive improvement cuttings and thinnings, and the lack of ready markets for small material offers serious consideration to foresters of New England. Pine may be used to rather small dimensions in certain localized industries, but cordwood size inferior hardwood is not readily disposed of. In this connection a survey was made of some of the cordwood markets throughout the transition zone, the results of which are seen in Table 1. The cities mentioned here offer an outlet of some 15,000 cords annually. At present the market is rather limited, since the farm woodlot is still the chief source of wood, the farmer disposing of his product directly to the consumer. However,

and representing operations on several thousand acres. They are listed as follows:

1. Planting (labor cost only) \$7.00 an acre
2. Weeding (each operation) \$4.25 " "
3. Improvement cutting \$15 to \$20 an acre
4. Thinning \$7 to \$8 per M.

Of these operations only the last two are possible of yielding revenue, so the cost of the first two must be charged directly to forest investment for the improvement of the crop. The latter operations are more often deferred until the sale of removed products is equal, at least, to the cost of the operation.

Just how these cost figures affect the silvicultural work necessary on the State Forests of the transition zone may be gained by referring to Fig. 2, an Analysis of the Massachusetts Lands Owned and Operated by the Diamond Match Company. The State Forests of this zone represent approximately 37,000 acres, and by applying the percentages given in Fig. 2, the acreages of the different type conditions which call for treatment may be derived. Since thinnings and improvement cuttings are so variable in cost and possible yields, they will not be considered.

<u>Operation</u>	<u>Area in Acres</u>	<u>Cost per Acre</u>	<u>Total Cost</u>
Planting			
(open and brush land)	1,073	\$7.00	\$7,511.
(convertible cordwood)	10,101	7.00	70,707.
Weeding			
(pine and inferior hardwood)			
(better and inferior hardwood)			
(pine and better hardwood)			
(indeterminate)	11,618	8.50	98,753.
		(2 operations)	
Total,	22,792		\$176,971
Average cost of all operations,		\$7.76 per acre.	

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Thus for approximately \$8.00 an acre numerous areas of hardwood and pine-hardwood may be weeded to produce sawtimber of higher quality and quantity than were it left untreated, as well as remaining open and semi-open areas planted throughout the State Forests. Planting, to be sure, has its place in a forest management plan, but every year countless acres of already stocked land are getting beyond the critical age for treatment. Weeding in just such areas, at no greater cost than planting, appears as sound economy, offering a means for the State to build up its numerous young natural stands which have followed recent cuttings. The result is one of healthy stands far in advance of plantations made at the same cost. As shown in the preceding table, the acreage in need of weeding is far in excess of that to be planted by nearly twelve times. The 10,000 acres of cordwood to be converted by planting should, due to the pressing need of weeding, be deferred and undertaken as time and money permit.

In the case of expenditures necessary for such a program of forest treatment, the \$176,971 is for labor cost alone and may be considered maximum, since many acres of so-called better and inferior hardwoods may be of such poor composition that treatment at this time may not be practical. This does not mean that such areas are detrimental to the State, for, on the contrary, they are serving the public in other ways than by the production of sawtimber. The ultimate objective, however, aims to put every available acre of State forest land on a sound productive basis.

The values of early forest management may be seen as actual demonstrations throughout the State. Comparisons of

with markets for several thousand cords of wood annually, many acres of second growth hardwood could be improved. Table 1 classifies the quality of wood and lists the cities with the customary means of delivery. Extending this survey to other sections of the State and locating other industries capable of using small wood, should increase the available markets by several thousand cords. A thorough knowledge of local markets by each forest supervisor will enable him to govern the quality and quantity of his cuttings from year to year.

Summary of Conclusions

The following conclusions are applicable to the State Forests of Massachusetts lying within the so-called transition Zone:

1. The State Forests in this region are composed almost wholly of second growth stands of volunteer origin and of old abandoned farms.
2. Very little forest management aside from planting and releasing has been undertaken.
3. Reversion to trees of inferior species invariably follows unmanaged forest operations.
4. No factor can more favorably affect the final crop at a small expenditure than does weeding.
5. All young stands of recent origin should be treated immediately if the percentage of better species is high enough to warrant it (4).
6. Many acres of middle age stands throughout State Forests, although of inferior quality, are of utmost importance to the public at large for their watershed protection and aes-

CLASSIFICATION OF THE PRINCIPAL CORDWOOD MARKETS ACCORDING TO GRADE OF WOOD DEMANDED AND THE USUAL POINT OF PURCHASE IN THE TRANSITIONAL ZONE OF HARDWOODS OF MASSACHUSETTS

Grade of Wood	Point of Purchase				Bought on road	Stumpage
	F.O.B. cars	Delivered in dealer's yard	Delivered in freight yard	Bought on the lot		
I All body wood, of good species, not less than 4" in the round, and all cleft. White birch desirable.	Boston and Seaboard	\$8-\$9		Westfield \$3.50 - \$4.50		
II All body wood, of good species, not less than 3" in the round, and all over 6" cleft.			Stockbridge \$10			
III Body wood, with some branch wood, not less than 2" in the round, and all over 6" cleft. Good species, but admits some inferior.			Springfield Chicopee Holyoke Easthampton Orange \$10-\$12	Holyoke \$10-\$12	Fitchburg Orange Athol Turners Falls Millers Falls \$4-\$5	Fitchburg Athol \$6.50 - \$7.00
IV Body and branch wood of inferior species - gray birch and chestnut not under 2" in the round.			Springfield Holyoke Worcester \$8.50	Fitchburg \$8	Athol Orange Turners Falls Millers Falls \$4.00	Fitchburg 75¢-\$1
V White pine limb wood. No substitutes.			Springfield \$5-\$6			

APPENDIX

List of Species Mentioned

White pine: Pinus strobus L.
 Red pine: Pinus resinosa, Ait.
 Scotch pine: Pinus sylvestris, L.
 Pitch pine, Pinus rigida, Mill.
 Norway spruce: Picea excelsa, L.
 White spruce: Picea canadensis, Mill.
 Hemlock: Tsuga canadensis, L.
 European larch: Larix europa, de C.
 Red oak: Quercus rubra, L.
 White ash: Fraxinus americana, L.
 Paper birch: Betula papyrifera, Marsh.
 Gray birch: Betula populifolia, Marsh.
 Black cherry: Prunus serotina, Ehrh.
 Pin cherry: Prunus pennsylvanica, L.
 Basswood: Tilia americana, L.
 Hard maple: Acer saccharum, Marsh.
 Red maple: Acer rubrum, L.
 Poplar or popple: Populus tremuloides, Michx. or
P. grandidentata, Michx.

Other Species Found in the Region

Red spruce: Picea rubens, Sarg.
 Black birch: Betula lenta, L.
 Yellow birch: Betula lutea, Michx.
 Beech: Fagus grandifolia, Ehrh.
 White oak: Quercus alba, L.
 Hickory: Hicoria alba, L.

thetic value, and they should be considered as such until it is feasible to convert them to species of better commercial value, but at the same time retain their former usefulness.

7. Thinnings should be made in all overcrowded middle age stands of good composition.

8. Final cuttings should be made with an idea of always obtaining reproduction containing the highest percentage possible of the better species.

9. Markets for small material, such as that removed from middle age stands in thinning and improvement cutting operations, are necessary before large scale forest management plans can be undertaken and be self-sustaining.

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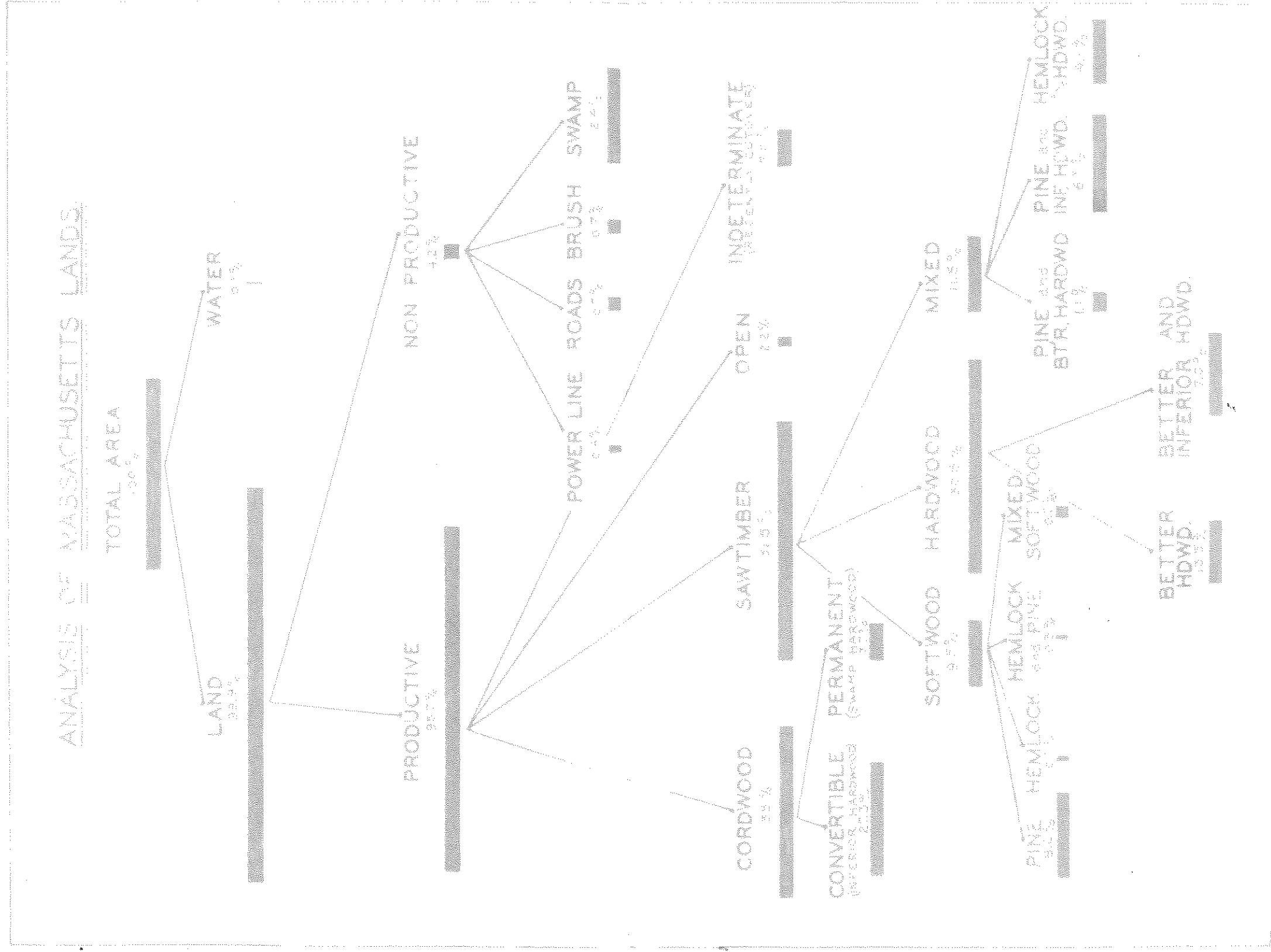


Fig II Deciduous Hardwood Lands in Mass.